



US Army Corps
of Engineers
North Central Division

Great Lakes Update

No. 118

May 3, 1994

CLIMATE CHANGE

Climate change is nothing new or unnatural. The climate has been undergoing change since the world began. This month we begin a series of articles on climate change by looking at its natural variability. It is a topic that is relevant to our readers because the recently completed Levels of Lake Superior and Ontario Reference Study recommended that its potential effects be considered in the regulation of Lakes Superior and Ontario.

Great Lakes water levels are the result of the interaction of natural, or climatic, as well as artificial factors which affect the water supply and discharge of water to and from the system. Figure 1 provides an illustration of the interaction of the climatic factors of precipitation and evaporation. (Other climatic phenomena which affect water levels of the Great Lakes are ice in the connecting channels and St. Lawrence River, aquatic weed growth in the rivers, changes in barometric pressure, wind induced waves, minor tides on the Lakes and crustal movement.) Artificial factors include the regulation of outflows from Lakes Superior

and Ontario, diversions of water into, out of and between the Great Lakes basins, dredging in the connecting channels and consumptive use, or that portion of water withdrawn from the Great Lakes for human and household uses which are not returned to the system.

Most climate change occurs on time scales far longer than a human lifetime: centuries or millennia or millions of years. We

think the weather we are accustomed to is "natural" because we cannot remember it any other way. Many people believe that an unchanging climate is "natural," and that climate change is something that the world is not used to. In practice, the rule of thumb has been to consider "climate" as the average weather conditions over 30-year time spans. Knowing all we can about natural climate change will help keep potential human-induced

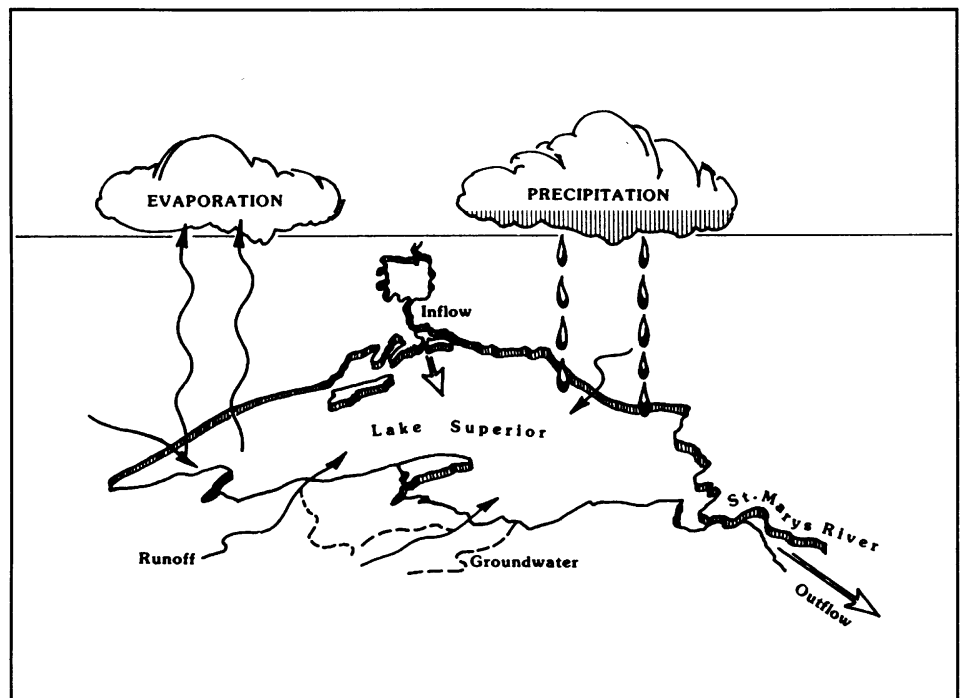


Figure 1. Interaction of precipitation and evaporation.

climate change in perspective.

In geologic time, consider the Carboniferous and Permian periods, about 345 to 270 million years ago. It was a time when the world was made up of shallow seas and swampy lands, much warmer and moister than today's climate. It was covered with profuse growths of giant ferns and primitive trees. It was this climate, much warmer than the worst doomsday predictions for the foreseeable future, that allowed the prehistoric Earth to store carbon from decayed vegetation in the form of coal and oil.

The "best-guess" graph of the Earth's geological-scale climate trends looks a lot like the temperature chart of a patient with alternating bouts of fever and hypothermia. The wiggles and dips at first seem random and disordered. Climatologists have long been looking for patterns and cycles in climate, and they have found some (Figure 2).

Patterns are important, because they may signify that certain aspects of climate change are understandable and even predictable. There are many kinds of climate cycles, some more firmly established than others. Over the very long term, some of the long cooling trends that started before the Cambrian era (about 570 million years ago) might be explained by the depletion of carbon-dioxide in an atmosphere once rich with it. Also, over the long term, some climate changes can be explained by the tectonic movement and buildup of the

continents.

A still more pronounced climate cycle of alternating ice ages and thaws is pretty well explained by the "Milankovitch hypothesis", which theorizes that these changes in how the Earth warms and cools are caused by regular

wobbles and tilts in the Earth's axis of spin, and by stretches in its orbit.

Another climate/weather variation pattern is called the El Niño Southern Oscillation (ENSO). This pattern results from coupled atmosphere-ocean interactions,

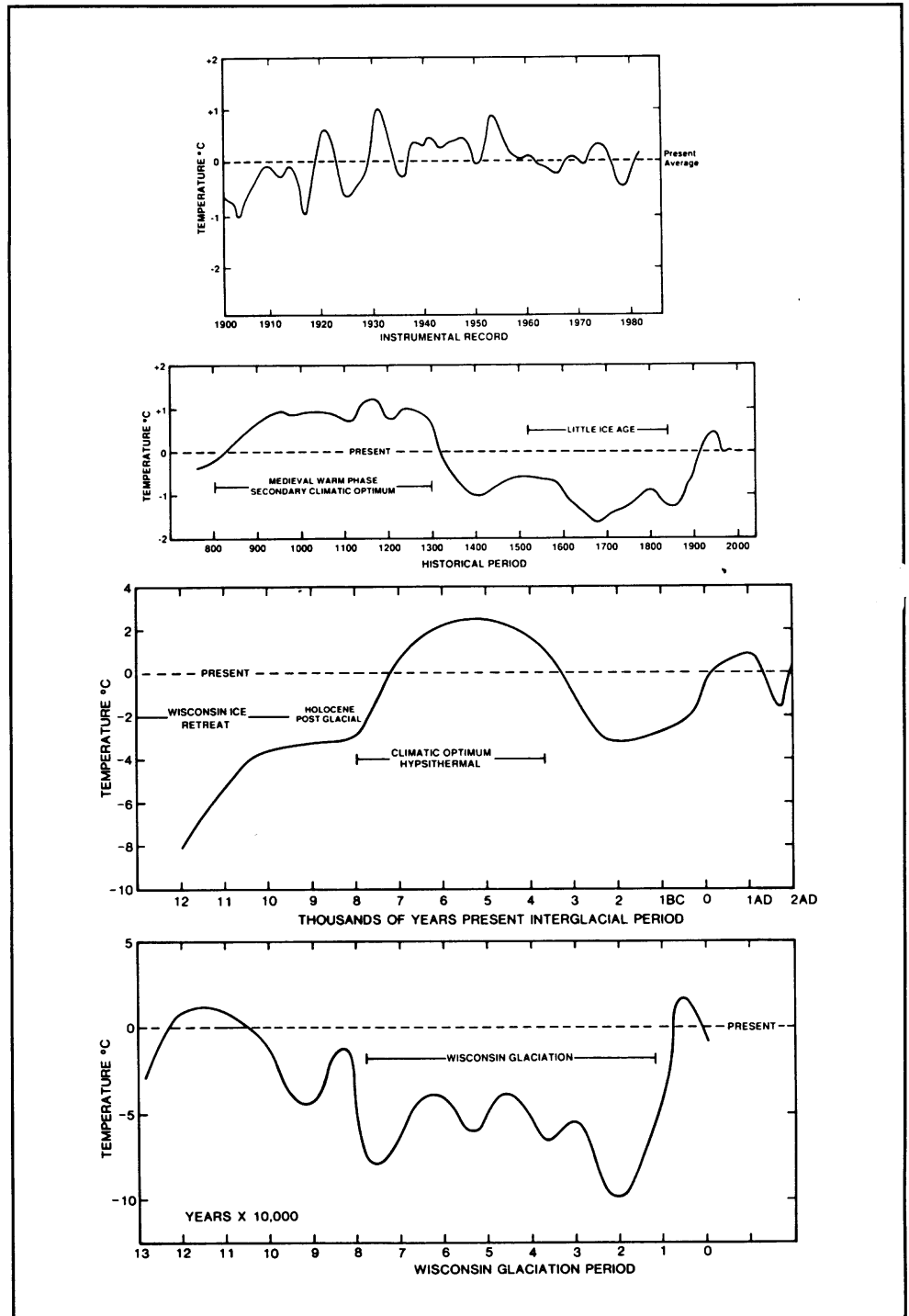


Figure 2 Estimated mean surface temperature (°C) in the Great Lakes Basin

and recurs at three- to 10-year intervals. The ENSO pattern is driven partly by alternating warming and cooling sea surface temperatures in the eastern and central tropical Pacific Ocean, which are caused by changes in upwelling currents. El Niño affects rainfall and temperatures over a large portion of the globe, with dramatic consequences to human activities like farming and fishing, which depend on weather and ocean currents. In turn, the changes in weather and atmospheric circulation affect the ocean currents.

So, the seemingly random squiggles on the world's temperature chart are not entirely random. Some are the result of natural phenomena. Others are not. Of the variability that remains as yet unexplained, some may be caused by processes we do not yet understand, and some may be truly random or chaotic variation. The branch of mathematics known as statistics has fairly rigorous tools for attacking the question of what is random and what is not. When these tools are applied to climate data, it appears that some of the variation in global mean temperature from year to year is, indeed, natural, unexplained, unpredictable, and random -- what scientists like to call "noise."

This is all relevant to more recent hypothesis to determine whether or not the Earth is getting warmer because of greenhouse gases caused by human activities. Without knowing what the natural variability of global temperature is (random or not),

scientists cannot be sure how much extra temperature change is being caused by humans. To take an imaginary example: if natural year-to-year variation in global mean temperature were only a tenth of a degree, and the warming from human activities were one whole degree, it would be very easy to detect. On the other hand, if the warming were a tenth of a degree and natural variation a whole degree, warming from human activities would be very hard to detect.

Scientists like to use the terms "signal" and "noise," borrowed from information theory, to discuss this problem. If the static on a telephone line is very loud, it is hard to hear a faint voice. On the other hand, if the voice is loud and the static faint (a high signal-to-noise ratio), it is easy to understand the voice.

Right now, the magnitude of any suspected human-induced global warming seems to be rather similar to the magnitude of natural background variation in temperature. This is why the so-called "green-house signal" is really difficult to detect with any certainty today. If, as many scientists predict, human-induced warming continues for a few more decades, the warming signal may perhaps be large enough to detect without much question. Even if a warming trend were found, there would still be the difficult problem of determining whether it was caused by human actions.

When we next address this issue we will talk about greenhouse

gases and their relevance to climate change. Meantime, you are invited to turn to Page 5 to review some information on climate change. Assess each statement as "Fact," "Myth," or "Opinion." Our answers will be given in the next issue.

Acknowledgments

Much of the information for this month's article was taken from "Reporting on Climate Change: Understanding the Science", with permission from the Environmental Health Center of the National Safety Council. Figure 2 is taken from the "Report of the First U.S.-Canada Symposium on Impacts of Climate Change on the Great Lakes Basin." Reference has also been made to the US Army Corps of Engineers, Detroit District's January 1987 booklet "Great Lakes Water Level Facts".

Meetings With the Public

The International St. Lawrence River and Lake Superior Boards of Control will hold meetings with the public this month and next month, respectively. The public meetings are to inform you of the Board's responsibilities and current activities and to hear your comments and suggestions. The times and locations of each meeting are as follows:

(a) The St. Lawrence Board will meet on Monday, May 15, 1995 from 7:00 to 9:00 p.m. at the Sarto Desnoyers Community Center located at 1335 Lakeshore Drive, Dorval, Quebec.

(b) The Lake Superior Board will meet with the public at 7:00 p.m. on Tuesday, June 27, 1995 at the Civic Centre, 99 Foster Drive, Sault Ste. Marie, Ontario.

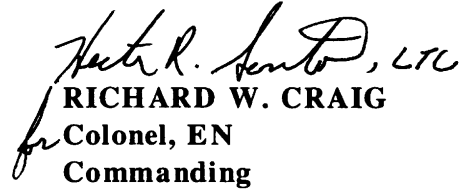
Do You Know?

The answer to last month's query is: Up to 99 percent of the total volume of standing surface water in the United States is contained in the Great lakes.

This month's question is: How many people in the United States and Canada are supplied with drinking water from the Great Lakes?

- (a) Up to 5 million
- (b) Up to 15 million
- (c) Up to 25 million

The answer will be provided in the next Update.


RICHARD W. CRAIG
Colonel, EN
Commanding

Climate Change: Fact, Myth or Opinion

1. Global warming on the scale many scientists anticipate would mean death for billions and potentially the end of the human race.
Fact_____ Myth_____ Opinion_____
 2. Global mean temperatures calculated for the last decade have been as high or higher than at any time since modern instruments began consistently recording temperature (the late 1800's). The increase from the longer-term average is still within the range of normal variation.
Fact_____ Myth_____ Opinion_____
 3. If humans had not interfered with nature by building industrial societies, global climate would not have changed significantly.
Fact_____ Myth_____ Opinion_____
 4. Most climate change occurs on time scales far longer than a human lifetime. Global change forced by human activity could cause it to occur faster.
Fact_____ Myth_____ Opinion_____
 5. The global warming that scientists anticipate from human activity will be unprecedented in the history of Earth.
Fact_____ Myth_____ Opinion_____
 6. The existence of a greenhouse effect is controversial among scientists.
Fact_____ Myth_____ Opinion_____
 7. The greenhouse effect has existed throughout most of Earth's history.
Fact_____ Myth_____ Opinion_____
 8. The greenhouse effect is now being amplified by increased concentrations of certain gases in the atmosphere as a result of human emissions.
Fact_____ Myth_____ Opinion_____
 9. A "scientific consensus" exists on most important scientific issues related to global change.
Fact_____ Myth_____ Opinion_____
 10. Carbon dioxide is the most important greenhouse gas.
Fact_____ Myth_____ Opinion_____
 11. Scientist are generally quite confident that there has been an increase in concentrations of greenhouse gases, especially CO₂, because they can measure them.
Fact_____ Myth_____ Opinion_____
 12. When glaciers and ice sheets melt, much of the melt water goes into the oceans. The melting has caused sea levels to rise hundreds of feet at the ends of successive ice ages. Since the last ice age began to end some 20,000 years ago, ocean levels have risen more than 300 feet.
Fact_____ Myth_____ Opinion_____
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Table 1

**Possible Storm Induced Rises (in feet) at Key Locations on the Great Lakes
May 1995**

| | Degrees of Possibility | | | | |
|-----------------------|------------------------|-----|-----|-----|-----|
| | 20% | 10% | 3% | 2% | 1% |
| LAKE SUPERIOR | | | | | |
| Duluth | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 |
| Grand Marais | 0.5 | 0.6 | 0.8 | 1.0 | 1.1 |
| Marquette | 1.0 | 1.2 | 1.5 | 1.7 | 1.9 |
| Ontonagon | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 |
| Point Iroquois | 0.9 | 1.1 | 1.3 | 1.5 | 1.6 |
| Two Harbors | 0.6 | 0.9 | 1.5 | 2.0 | 2.6 |
| LAKE MICHIGAN | | | | | |
| Calumet Harbor | 1.3 | 1.6 | 1.8 | 2.0 | 2.2 |
| Green Bay | 1.8 | 2.0 | 2.3 | 2.5 | 2.7 |
| Holland | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| Kewaunee | 0.6 | 0.8 | 0.9 | 1.1 | 1.2 |
| Ludington | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 |
| Milwaukee | 0.9 | 1.1 | 1.3 | 1.5 | 1.6 |
| Port Inland | 0.8 | 1.0 | 1.3 | 1.6 | 1.9 |
| Sturgeon Bay | 0.8 | 1.0 | 1.4 | 1.7 | 2.0 |
| LAKE HURON | | | | | |
| Detour Village | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 |
| Essexville | 1.9 | 2.2 | 2.6 | 2.8 | 3.1 |
| Harbor Beach | 0.6 | 0.8 | 1.0 | 1.2 | 1.3 |
| Harrisville | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 |
| Lakeport | 0.8 | 1.0 | 1.3 | 1.4 | 1.6 |
| Mackinaw City | 0.6 | 0.7 | 0.8 | 0.9 | 0.9 |
| LAKE ST. CLAIR | | | | | |
| St. Clair Shores | 0.4 | 0.5 | 0.6 | 0.7 | 0.7 |
| LAKE ERIE * | | | | | |
| Barcelona | 1.0 | 1.2 | 1.5 | 1.7 | 1.9 |
| Buffalo | 2.1 | 2.6 | 3.1 | 3.5 | 3.9 |
| Cleveland | 0.9 | 1.0 | 1.2 | 1.3 | 1.4 |
| Erie | 0.9 | 1.1 | 1.4 | 1.6 | 1.7 |
| Fairport | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 |
| Fermi Power Plant | 1.4 | 1.6 | 2.0 | 2.2 | 2.5 |
| Marblehead | 1.0 | 1.2 | 1.6 | 1.8 | 2.1 |
| Sturgeon Point | 1.4 | 1.8 | 2.3 | 2.8 | 3.3 |
| Toledo | 1.9 | 2.3 | 2.7 | 3.0 | 3.3 |
| LAKE ONTARIO | | | | | |
| Cape Vincent | 0.5 | 0.6 | 0.8 | 0.8 | 0.9 |
| Olcott | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 |
| Oswego | 0.5 | 0.7 | 0.9 | 1.0 | 1.2 |
| Rochester | 0.5 | 0.6 | 0.8 | 0.8 | 0.9 |

* The water surface of Lake Erie has the potential to tilt in strong winds, producing large differentials between the ends of the lake.

Note: The rises shown above, should they occur, would be in addition to the still water levels indicated on the Monthly Bulletin. Values of wave runoff are not provided in this table.

Great Lakes Basin Hydrology

During the month of April precipitation was below average on the Lake Superior and Ontario basins, while it was above average on the Lake Michigan-Huron and Erie basins. For the year to date, precipitation is about 1% above average for the entire Great Lakes basin. The net supply of water to each of the Great Lakes in April was below average, except for Lake Erie which was above average. Table 2 lists April precipitation and water supply information for all of the Great Lakes.

In comparison to their long-term (1918-1994) averages, the April monthly mean water level of Lakes Superior and Ontario was 3 and 7 inches below average respectively, while Lakes Michigan-Huron, St. Clair and Erie were 2, 6 and 6 inches above average respectively. Shoreline residents are cautioned to be alert whenever adverse weather conditions exist, as these could cause rapid short-term rises in water levels. Should the lakes approach critically high levels, further information and advice will be provided by the Corps of Engineers.

**TABLE 2
GREAT LAKES HYDROLOGY¹**

| PRECIPITATION(INCHES) | | | | | | | | |
|-----------------------|-------------------|------------------------|-------|-----------------|-------------------|------------------------|-------|-----------------|
| BASIN | APRIL | | | | YEAR-TO-DATE | | | |
| | 1995 ² | Average (1900-1991) | Diff. | % of Average | 1995 ² | Average (1900-1991) | Diff. | % of Average |
| Superior | 1.9 | 2.0 | -0.1 | 95 | 6.9 | 7.1 | -0.2 | 97 |
| Michigan-Huron | 3.4 | 2.6 | 0.8 | 131 | 9.0 | 8.5 | 0.5 | 106 |
| Erie | 3.9 | 3.1 | 0.8 | 126 | 10.8 | 10.4 | 0.4 | 104 |
| Ontario | 2.1 | 2.9 | -0.8 | 72 | 8.9 | 10.6 | -1.7 | 84 |
| Great Lakes | 2.9 | 2.5 | 0.4 | 116 | 8.7 | 8.6 | 0.1 | 101 |

| LAKE | APRIL WATER SUPPLIES ³ (CFS) | | APRIL OUTFLOW ⁴ (CFS) | |
|----------------|---|------------------------|----------------------------------|------------------------|
| | 1995 ² | Average (1900-1989) | 1995 ² | Average (1900-1989) |
| Superior | 94,000 | 149,000 | 66,000 | 69,000 |
| Michigan-Huron | 218,000 | 286,000 | 186,000 ⁵ | 182,000 |
| Erie | 72,000 | 66,000 | 219,000 ⁵ | 203,000 |
| Ontario | 29,000 | 93,000 | 250,000 | 249,000 |

¹Values (excluding averages) are based on preliminary computations.

²Estimated.

³Negative water supply denotes evaporation from lake exceeded runoff from local basin.

⁴Does not include diversions.

⁵Reflects effects of ice/weed retardation in the connecting channels.

CFS = cubic feet per second.

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